



RESEARCH IN CLINICAL PERIODONTOLOGY: CURRENT APPROACHES AND FUTURE PERSPECTIVES

Dental Science

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ABSTRACT

Even with the exciting advances seen in today's periodontal treatment, more promising therapies loom on the horizon. Research in the field of periodontology has witnessed a tremendous upsurge in the last two decades unveiling newer innovations in techniques, methodologies, and material science. One of periodontology's greatest strengths is that it is not a static field; rather, it continues to evolve and readjust its focus on the basis of contemporary research spanning a vast array of scientific endeavour. This article deals with various new techniques which are emerging in the field of periodontology.

KEYWORDS

INTRODUCTION

The common facts of today are the product of yesterday's research.

-Duncan Mac Donald

Research is pondered as a terminus from known to unknown. It can also be defined as a scientific and systematic search for pertinent information on a specific topic. Periodontal Research accord with diseases of the supporting and investing structures of the teeth including the gums, cementum, periodontal membranes, and alveolar bone. Over the last two decades Research in the field of periodontology had observed a stupendous boom in discovering newer innovations in technique, methodologies, and material science.

One of periodontology's greatest strengths is that it is not a fixed field; preferably, it continues to evolve and readjust its focus on the basis of contemporary research spanning a vast array of scientific endeavour.

Precise evaluation of individual risk is considered one of the most important aspects of periodontal examination, diagnosis, prognosis and treatment planning. To date, this has been puzzling, but, nonetheless, it will remain an important aspect of periodontal research and practice in the years to come.

In point of fact, it is now perceptible that in reckoning to plaque, supplementary risk factors — such as opportunistic pathogens, environmental influences, genetics, host responses, connective tissue metabolism and bone metabolism — are censorious to the clinical manifestation of periodontitis (figure 1).

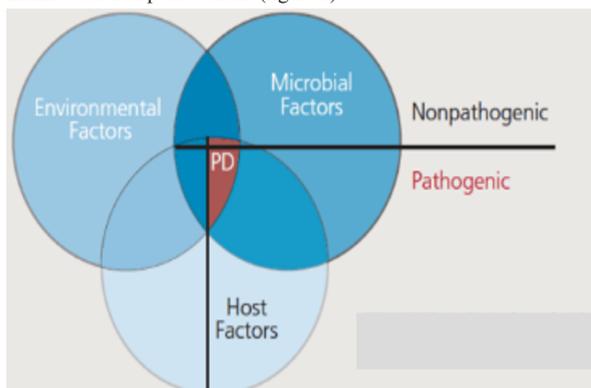


FIGURE 1: Periodontal Risk: A Patient Centred Paradigm Apprehending this complex nature has led to the evolution of a more knowledgeable management process. Alluring list of topics that are presently under investigation have been discussed below.

3-D PRINTING IN PERIODONTOAL REGENERATION:

3D printing is the term used to enhance manufacturing approach that builds material layer by layer.

Different techniques of 3D printing includes stereo lithography, Photopolymer jetting, selective laser sintering, fused deposition modelling, and powder binder printers. To attain success in bone regeneration, the template should exemplify mechanical strength close to vernacular tissues to support target cells, the abutting tissues, and newly formed ones, mainly in load-bearing areas, until full tissue genesis is achieved. The below mentioned (figure -2) illustrates multiphasic scaffold with channel-like “fiber-guiding architecture” of the PDL compartment displaying a thickness of 0.250 mm to mimic the width of an adult periodontal ligament space.

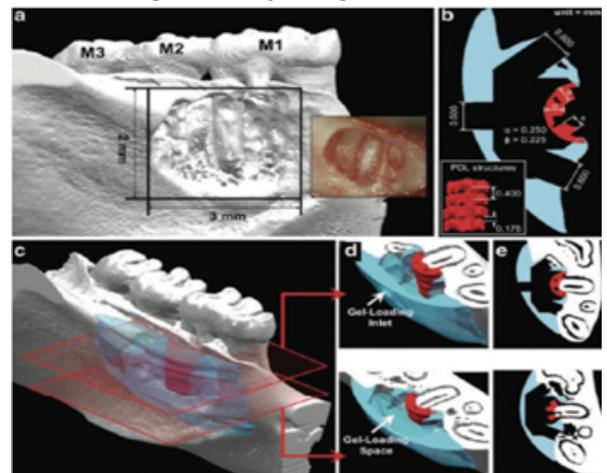
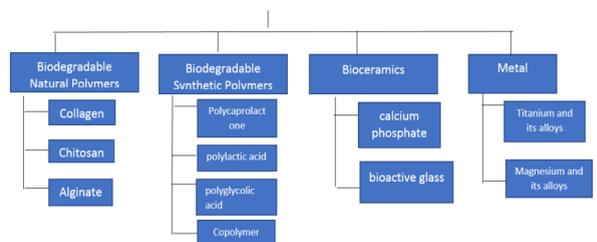
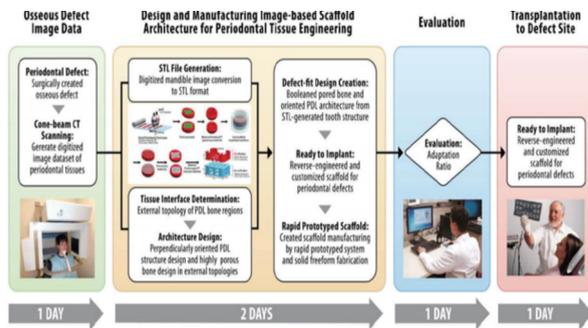


FIGURE 2- Multiphasic scaffold

Biomaterials Used in the Fabrication of 3D Scaffolds:



Study was done by Otavio et al in 2020<sup>2</sup> presents a technique that describes a digital workflow for flapless implant surgery after onlay block bone graft healing in the aesthetic area. The technique presented, using images captured from intraoral digital scanning and CBCT images, describes a custom 3D-printed surgical guide to remove graft block fixation screws, in a flapless manner, with a digital workflow. CAD models are produced based on computed tomography (CT) scans of a patient-specific bone defect to develop a custom-made bone graft substitute (figure 3).<sup>3</sup>

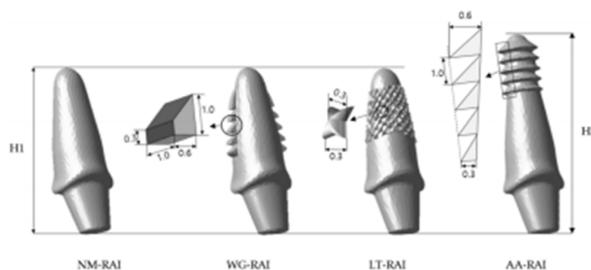


**FIGURE 3: Preparation of CAD Models**

Determiner aspect of 3-d printing is the concept of root analogue: a new advancement in implant dentistry. These are customized dental implants which not only preserve more hard and soft tissues but also reduce rehabilitation time and prevent the second surgical intervention, leading to overall cost reduction and an improvement in the patients' psychological outlook for dental treatment.

With the amalgamation of cone beam CT, 3D data and high-end CAD/CAM technology it was feasible to manufacture a root analogue implant with sufficient precision.

A study was done by Lee et al in 2020<sup>4</sup> with the aim to biomechanically evaluate the initial stability of a patient-specific root analogue implant (RAI) design with drilling protocol by comparing it to designs without drilling protocol through a 3D finite element analysis (FEA). Four modified RAI shapes were designed with the press-fit implantation method: Non-modified, wedge added at root surface, lattice added at root surface, and apex-anchor added at root apex (AA) (figure 4).



**Figure 4-Different Shapes of RAI**

It was concluded that additional drilling in the tooth extraction socket and use of an RAI with an apex-anchor has a positive effect on lowering the stress concentration on cortical bone and reducing micro-displacement of the RAI.

**MINIMALLY INVASIVE PROCEDURES:**

The fundamental elucidation of a periodontal surgical procedure that was described as minimally invasive was given in 1995. To battle oral microbiota and re-establish lost alveolar bone support, intuitive clinicians, scientist and researchers have turned novel and sometimes far flung avenues and explored new frontiers of physical laws, pharmacological molecules and new concepts as available for other medical situations.

The newer trends are

1. Perio Protect
2. Tri-immunophasic periodontal therapy (TIP)
3. S.M.A.R.T
4. Flapless technique for bone graft

**PERIOPROTECT:** It is a extensive method that is custom defined for individual patients to help manage biofilms, growing in the spaces or pockets between teeth and gum tissue. The method is a fusion of treatments, including a non-invasive chemical debriding therapy used in concurrence with traditional mechanical debriding procedures.

**TRI-IMMUNOPHASIC PERIODONTAL THERAPY:** US periodontal therapist William Hoisington had set about a new technique in treating periodontal disease which solves the issue of periodontium in an entirely new way.

**TIP periodontal therapy procedures are:**

1. Bone One Session Treatment
2. Controlling Occlusal Forces
3. Oral Hygiene reinforcement with adjuvant modalities
4. Life Style modification
5. Enhancing nutrition and exercise

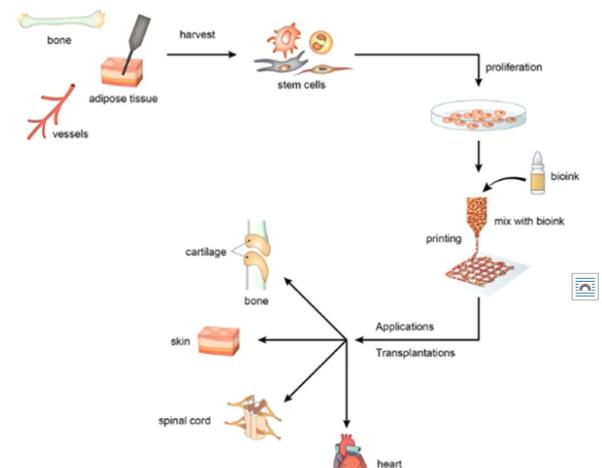
**S.M.A.R.T:** The Subperiosteal Minimally invasive Aesthetic Ridge Augmentation technique (SMART) was evolved as a substitute to traditional guided bone regeneration procedure.

Study was done by Ana et al in 2020<sup>5</sup> at describing a flapless, minimally invasive clinical crown lengthening with an osteotomy performed using a piezoelectric ultrasound. It can be concluded that the minimally invasive clinical crown-lengthening technique was effective in repositioning the gingival margin with no postoperative complications.

**TISSUE ENGINEERING:**

Tissue engineering is an exclusive field of science based on the principles of cell biology, developmental biology and biomaterial science, aimed at fabricating new tissue to replace lost or damaged tissues. The cue components of tissue engineering are stem cells, morphogens, scaffolds and bioreactor. The plan of action employed in order to engineer the tissues can be designated into three major classes: Cell conduction therapy, Cell induction therapy and cell transplantation.

A great many animal and human studies have yied proof supporting the belief that periodontal ligament stem cells (PDLSCs) can be yoked for regeneration of periodontal tissues. A novel approach of direct application PDLSCs using stem cell assistance in periodontal regeneration technique (SAI-PRT) for the regeneration of intrabony periodontal defects bypassing ex vivo cultures was used by overcoming the limitations and concerns of ex vivo cell culture techniques as they are costly and sensitive and there is chance of loss of stem cells during cell passage, genetic alteration and tumorigenic potential. The present evidence indicates that adipose tissue stem cells alone or in combination with platelet-rich plasma offer a valuable approach to promote periodontal regeneration (figure-5).



**FIGURE 5-Harvesting Of Adipose Tissue**

A study done by Carlos et al in 2020<sup>6</sup> sought to characterize membranes produced through a modified protocol for concentrated growth factors (CGF) associated with activated plasma albumin gel (APAG). Study indicates that the protocol may provide autologous moldable and stable biomaterials for use as a soft tissue barrier,

offering the basis for further research on its effectiveness for guided tissue regeneration.

Stem cell therapy reminisce about the silent, intentional, highly regular, substitution of tattered out cells by the "Mother Nature." "Credit to the Mother Nature for the thought process to make the best of the waste and tissue engineering made easy chairside.

### NANOTECHNOLOGY IN PERIODONTICS

Recently, nano dentistry has been launched as an extension of nanotechnology that has been beneficial for diagnostic procedures, treatment, and prevention of oral and dental diseases thereby manifesting noticeable improvement in dental health. Nano originated from a Greek word which means "dwarf." A widely used definition for nanotechnology is "The creation and utilization of materials, devices, and systems through the control of matter on the nanometre scale (1-100 nm), i.e. at the level of atoms, molecules, and supramolecular structures.<sup>7</sup> Nanotechnology, which utilizes nano volumes and/or nano flows or less in separation sciences, is not limited to the production of micromachined devices, but also being used in bio/clinical research areas of single cell analysis, DNA, RNA, and protein/peptide analysis, in hyphenated technology such as capillary liquid chromatography–electrospray ionization mass spectrometry, sampling techniques, drug delivery, imaging, early detection of tumours, and cancer research.<sup>8</sup> The application of nanotechnology in the periodontal management was put forward by Kong et al.<sup>9</sup> the concept given by their researches formulated many concepts regarding tissue engineering in periodontal regeneration.

### NANOROBOTIC DENTIFRICES (DENTIFROBOTS)

Nanorobotic dentifrices, either by mouthwash or toothpaste, cover all subgingival, or digest trapped organic matter into harmless and odourless vapours. These nanorobot dentifrices called dentifrobot scan identify and destroy pathogenic bacteria that exist in the plaque and oral cavity. Imperceptibly small dentifrobots (1-10  $\mu$ ), slithering at 1-10  $\mu$ /s, have the advantages of being inexpensive and safe as they are purely mechanical devices that would safely deactivate themselves if swallowed.

### PERIODONTAL DRUG DELIVERY

Drugs can be assimilated into nanospheres composed of a biodegradable polymer. This authorises timely release of the drug as the nanospheres degrade and specific site drug delivery. For optimisation, restininin in which tetracycline is incorporated into microspheres for drug delivery by local means to a periodontal pocket.

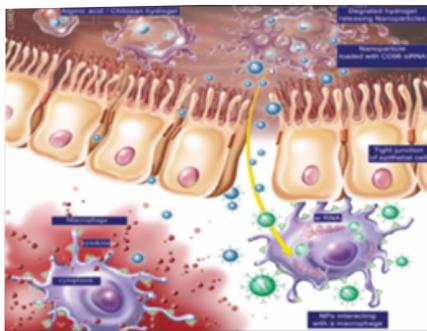


FIGURE 6- Nanoparticles in targeted strategy

With oral intake of nanoparticles (NPs) encapsulated in a hydrogel, the bioactive component is distributed specifically in the colon. (Figure-6) In targeting strategy, NPs are covered with an antibody, whose ligands are overexpressed in inflamed areas. The NPs accumulate and the drug is released in the specific area.<sup>10</sup>

Silver Nanoparticles can be added to Platelet-Rich Fibrin to improve its properties. In a study by Khorshidi et al it can be seen that modification of L-PRF with SNP improves the mechanical properties and antibacterial activity of the L-PRF.<sup>11</sup> It can play an important role in regenerative procedures. According to Ghaznavi et al adding gold nanoparticles to advanced-platelet-rich fibrin and fibrin and platelet by products could be an alternative strategy to improve osteogenic capacity of stem cells.<sup>12</sup>

### ADVANCES IN IMPLANT

### PARADIGM SHIFT REGARDING SINUS AUGMENTATION

The atrophic posterior maxilla is a challenging site for oral rehabilitation with dental implants due to insufficient bone volume. Crestal or lateral window approaches for sinus augmentation are the most common surgical techniques to overcome the vertical deficiency of the atrophic posterior maxilla.<sup>13</sup> A piezoelectric surgical technique enables bone cutting with precision and has a low associated risk of sinus perforation. Furthermore, the ultrasonic piezoelectric surgical device minimizes damage to soft tissue and other structures, such as nerves and blood vessels, while cutting bone, even in cases of accidental contact. When a sizeable membrane perforation occurs, delay of sinus bone graft is recommended because mucosal perforation repair with a collagen membrane cannot completely prevent sinusitis.<sup>14</sup> To enhance new bone formation in the sinus, the utilization of a replaceable bony window is strongly recommended. Unlike collagen membranes, replaceable bony windows act as a homologous osteoinductive barrier; as such, homologous bony windows are free from viral cross-contamination of animal or human origin, and precise adaptation of lateral bony windows completely prevents soft tissue ingrowth. Repositioning of the bony window clinically led to complete bone healing between the replaceable bony window and more mature bone was observed along the floor of the replaceable bony window than at the centre of the graft site.<sup>15</sup>

"IPG" DET is a well-established and efficient dental implantation protocol that combines Concentrated Growth Factors (CGF with stem cells Cd34+) along with bone grafting and intentional perforation of sinus membrane towards a rapid implant insertion. With "IPG" DET, sinus gains the ability to adapt to new conditions and form new bone bilaterally to implant thus avoiding an SFA procedure.<sup>16</sup>

### NEW BIOMATERIALS FOR MANAGING PERIIMPLANTITIS

Peri-implantitis is an inflammatory disease of hard and soft tissues around osseointegrated implants, followed by a progressive damage of alveolar bone. In an attempt to prevent/treat bacterial colonization on dental implant system components, metallic nanoparticles have been investigated as a potential coating material on titanium substrates.<sup>17</sup> Nowadays, an interesting paradigm shift brings up new possibilities to antimicrobial drug applications. Considering that antibiotics still remain as important protagonists to treat infection diseases, the idea in reducing microbial resistance can be achieved by controlled and directed delivery of specific drugs. Hydrogels are hydrated polymers that exhibit meaningful therapeutic versatility, designed for human application.<sup>18</sup> This hydrogel engine was shown effective as a coating on titanium implants without inducing an inflammatory reaction<sup>19</sup> (figure-7). The idea was to develop an antibiotic-loaded hydrogel loaded to offer a local protection for implants against bacteria without interfering with bone apposition or inducing a local or systemic inflammatory reaction. Another recent approach is layer-by-layer (LbL) coating deposition, which could lead to higher efficacy and fewer adverse effects regarding controlled release of antimicrobial substances. The multilayer coating buildup via LbL is based solely on electrostatic attractions between polyelectrolytes with opposite charges.<sup>20</sup>

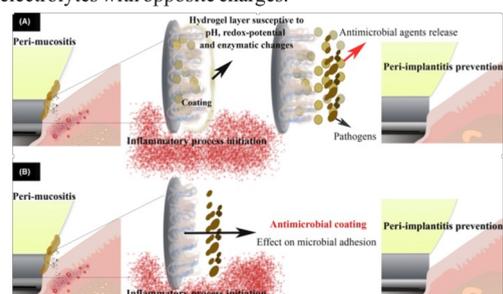
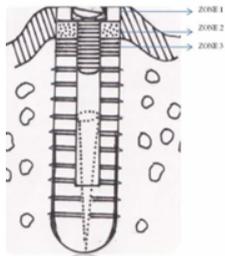


FIGURE 7- Coating of Hydrogel On Implant Surface

Proposed antimicrobial mechanism addressed to peri-implantitis prevention. Biomaterial coating onto Ti substrate to release antimicrobial substances after inflammatory process initiation. Also a recent innovative DV-PIMS™ Technique was introduced by Deepak et al in 2019<sup>21</sup> to evaluate implant stability and flow of injectable PRF (i-PRF) of regular implant and modified innovative design implant. (fig-8)

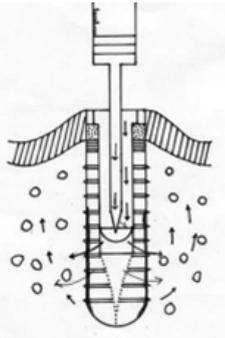


**FIGURE 9-Line diagram showing flow of i-PRF-like dye through modified implant**

Zone 1 = polished collar

Zone 2 = dotted collar

Zone 3 = micro-threads



**FIGURE 9-Line diagram showing flow of i-PRF-like dye through modified implant**

Therefore this (DV-PIMS) method aims to explain new implant design that disperses an i-PRF solution from inside out. The screw section of the new implant is made of a reservoir running vertically down inside (figure 9). That reservoir is filled with (injectable) PRF, and then a cover screw is placed. The solution will begin to slowly diffuse out, through the vents in implant, keeping biofilms from forming or avoiding at the screw–bone interface and accelerate healing process

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